



ECOLOGICAL RESEARCH PROGRAM

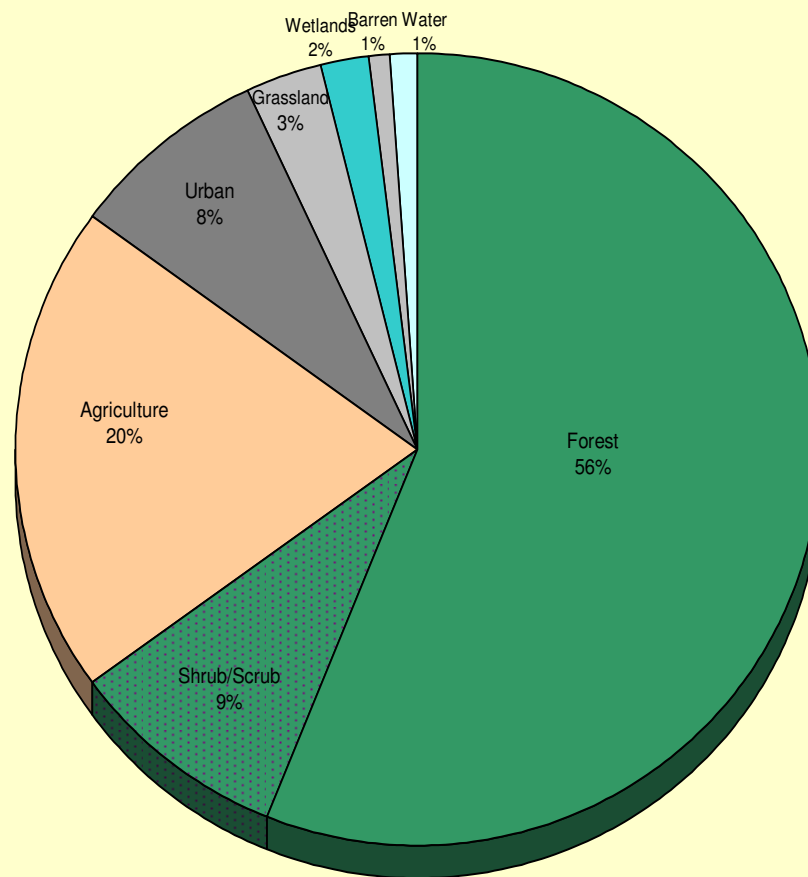
Willamette-Ecosystem Services Project





ECOLOGICAL RESEARCH PROGRAM

Willamette River Basin Land Use





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Overall Goal:

The W-ESP seeks to provide a scientific basis in the form of a decision support system for valuing and projecting ecological services resulting from alternative management decisions

Objectives:

Provide a model-based approach that predicts responses of ecosystem services to probable future conditions.

Identify critical knowledge gaps in the ecological processes underlying ecosystem services.

Quantify ecosystem services, including their distribution, status, and responses to current and projected future conditions.

Evaluate net benefits of bundled ecosystem services and tradeoffs among management actions that affect these services.

CLIMATE OF OPPORTUNITY

Why the Willamette?

- Willamette “Ecosystem Service District” provides a broad range of Land-Use/Land-Cover, stressors, gradients, and diverse, linked settings
- WED Alternative Futures research experience (mid 1990’s) = rich data sets, experienced researchers, potential collaborators (NRCS, USACE, USDA-FS, USGS, OWOW, etc.)
- Well Connected Research and Regulatory Entities now Working toward future Ecosystem Service trading (Region X)
- Multiple related Star Grant recipients (OSU, OU, PSU)
- Willamette Partnership (State Non-Profit)
- Trading Scenario for Temperature (riparian wetland ecosystem service) rapidly developing – EPA Funding with Region X oversight
- ORD Multi-Year Plan – Ecosystem Research Program: provides explicitly context



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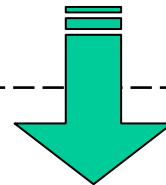
Outcomes:

- Clean rivers
- Fish & Wildlife
- Flood control
- Timber& Crops
- Wetlands

Forcing Variables:

- Predicted climate change
- Air pollution
- Land use management
- Population growth

Place-Based Societal Issues & Values



Research Targeted to Develop Ecological Response Functions (ERF) and Ecological Trade-off Functions (ETF)

Natural & Anthro-pogenic Stressors
Past Present & Future

Ecosystem Structure & Functioning
Production Pools
Decomposition Flows
Ag-/De-gradation
Land-Water Interactions

C-Sequestration

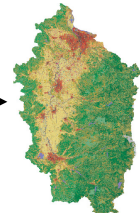
N-control

Critical habitat

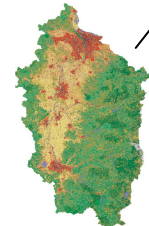
Riparian wetland ES bundles

Other services

Mapped Ecosystem Services



Future Projections



ERFs
ETFs

Projected and Quantified Bundles of Ecosystem Services

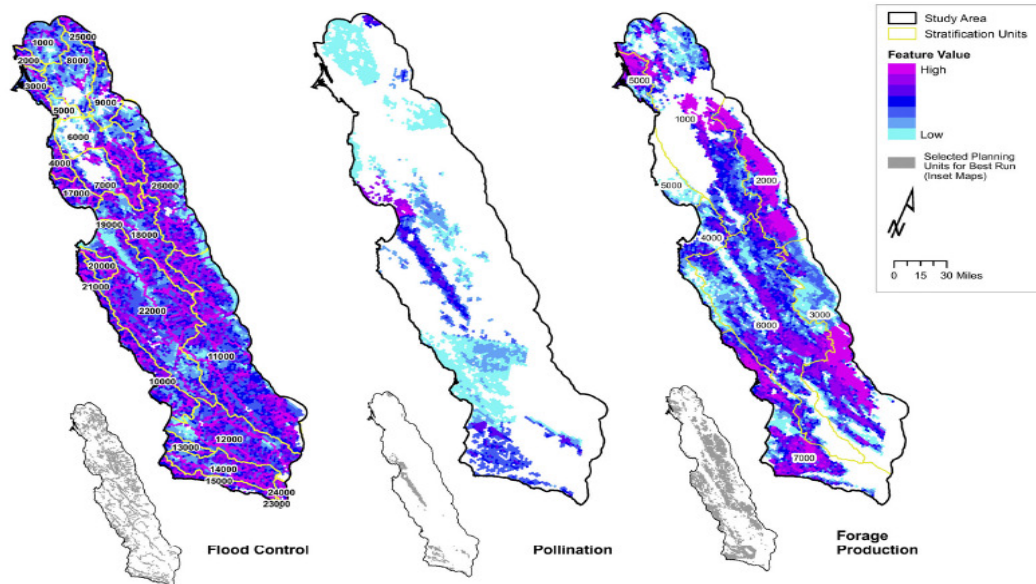
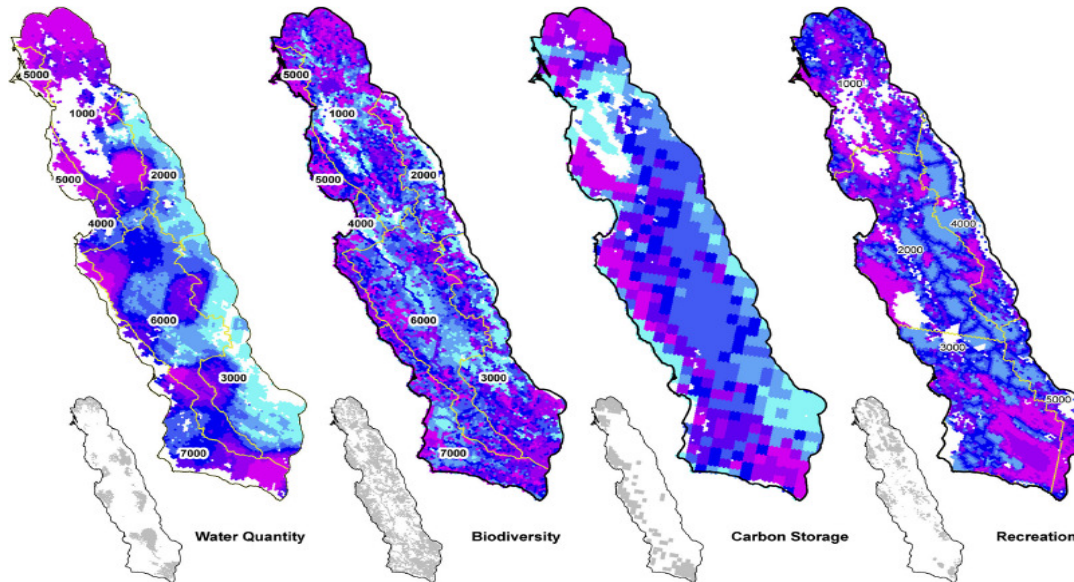
W-ESP Decision Support System

Societal Response & EPA Policy Actions

Tradable Ecosystem Service Units

Futures & Trading

- Cost
- Optimization
- Market Forces
- Valuation



Inventory and mapping the location and value of Ecosystem Services is an essential component of W-ESP (Chan et al. 2006)

Definition of Terms

- **Forcing Variables**
 - Factors, both natural and anthropogenic, affecting quantifiable changes in the status (e.g sinks, rates) of ecosystem processes

- **ERF: Ecosystem Response Function**
 - The relationships between ecosystem services and the natural and anthropogenic forcing variables affecting them

Approach to Conceptualizing W-ESP Forcing Variables and Their Priority

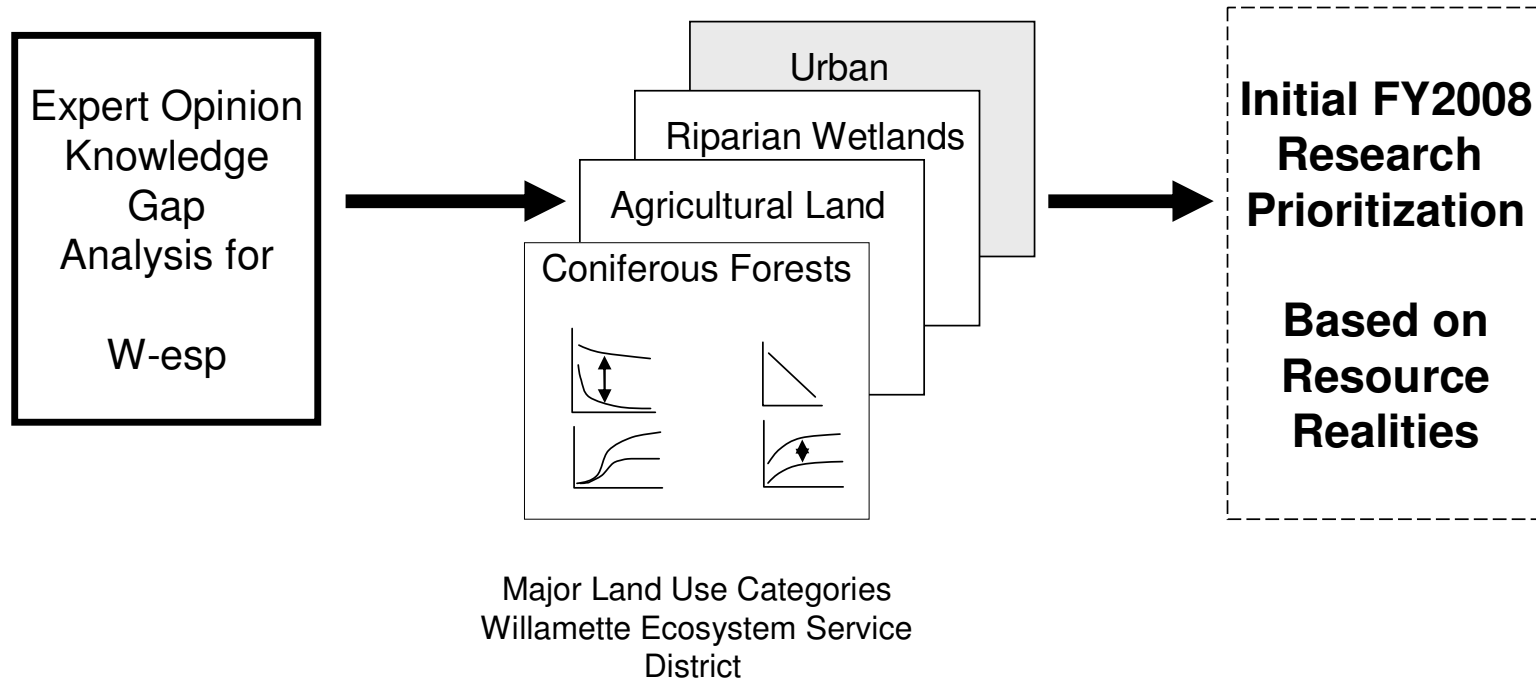
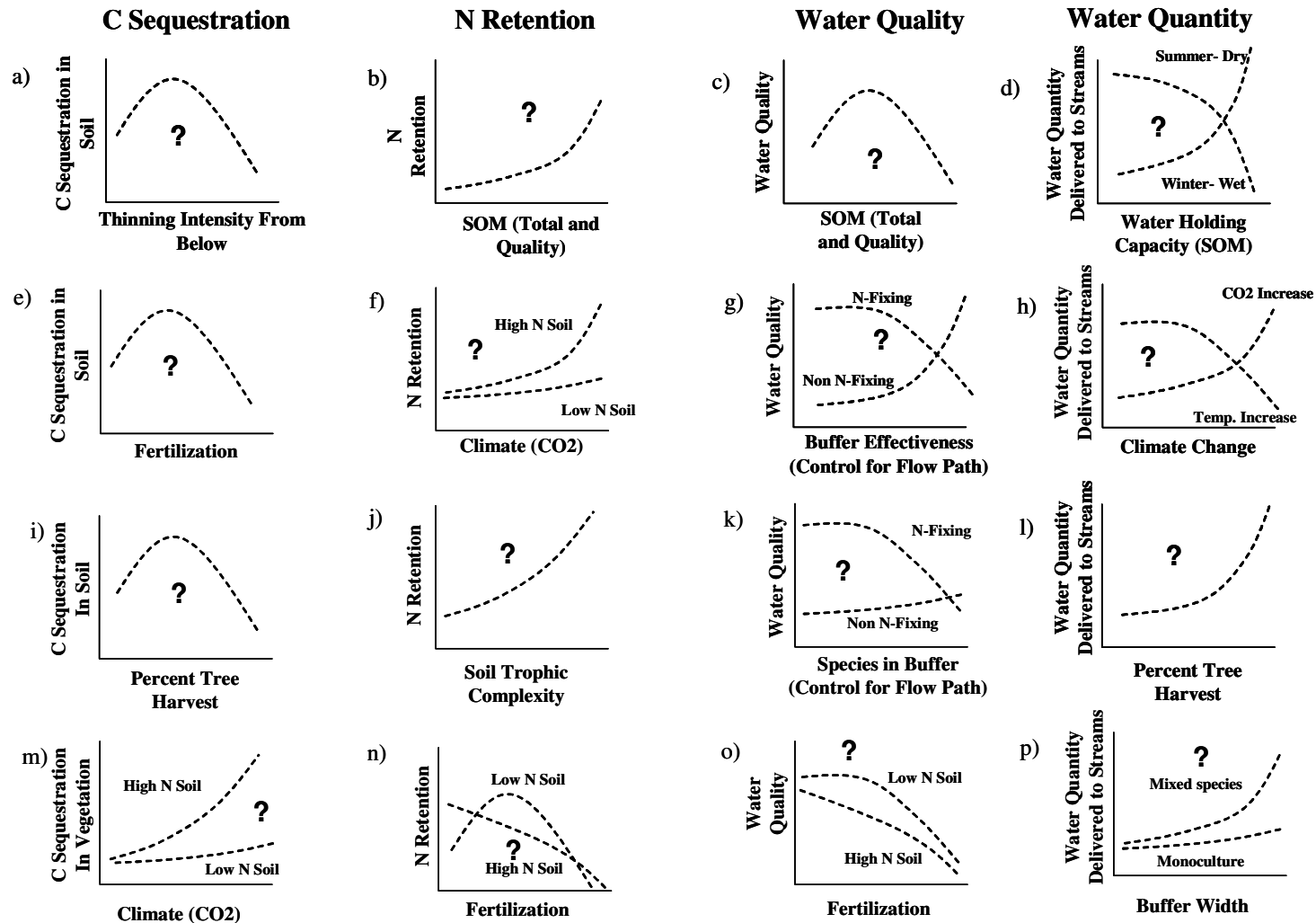


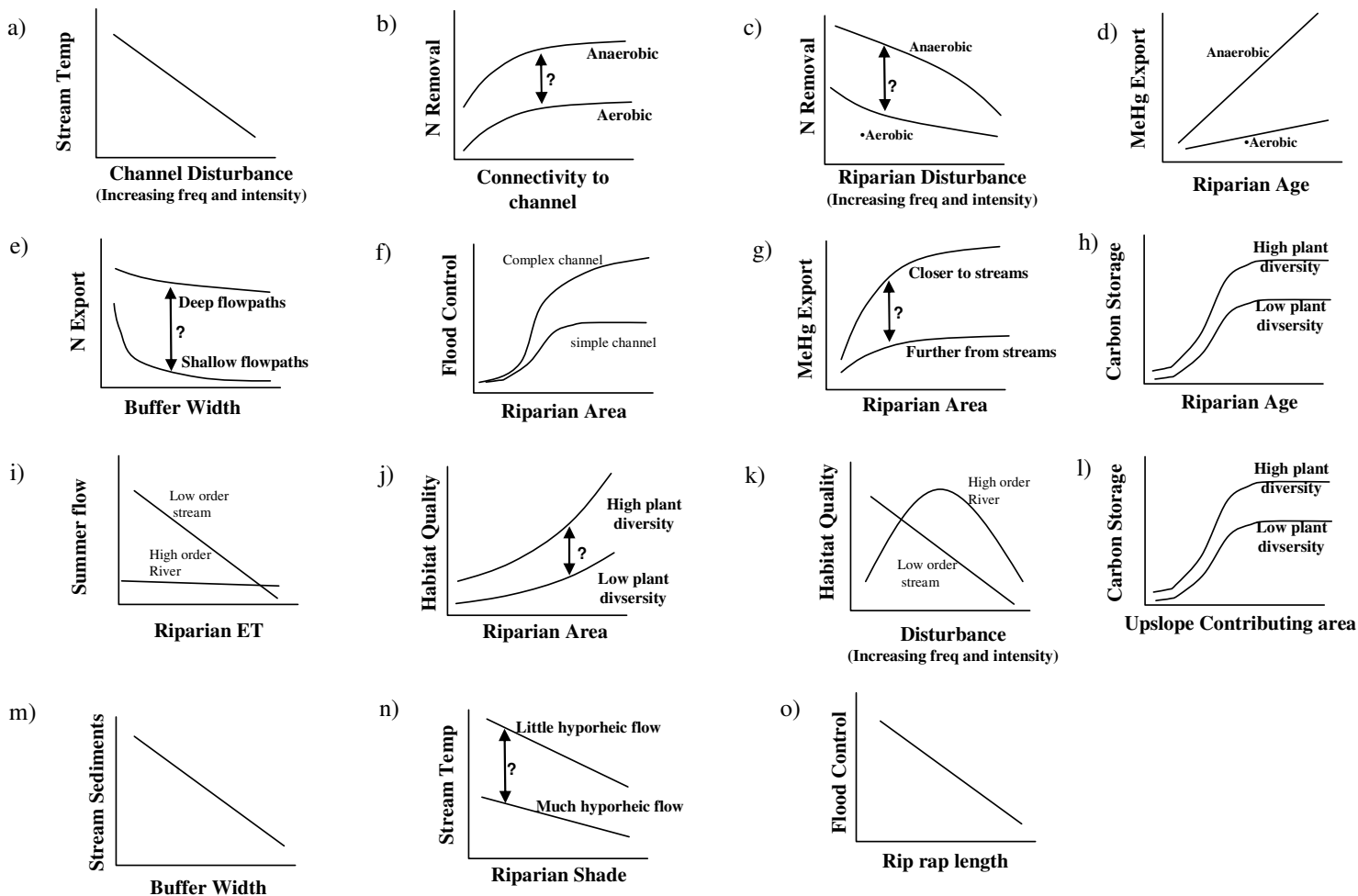
Table 2-3 Expert opinion research prioritization on Water Supply, by land use in the Willamette Basin.

| Ecosystem type | 2001 Spatial extent* % | Expected change in spatial extent of ecosystem type (--- to +++) | Impact on Service (--- to +++) | Knowledge gaps (+----) |
|-----------------|------------------------|--|--------------------------------|------------------------|
| Urban/Developed | 7.7 | ++ | --- | + |
| | | | | |
| | | | | |
| Wetland | 2.0 | 0/+ | ++/- | ++ |
| | | | | |
| Grassland | 2.9 | -/0 | + | + |
| Water | 1.0 | 0/+ | ++/-- | + ?climate change |
| Oak Savannas | nq | - | + | + |
| Barren | 0.9 | | | |
| Snow/Ice | 0.3 | --- | +++ | +++ |

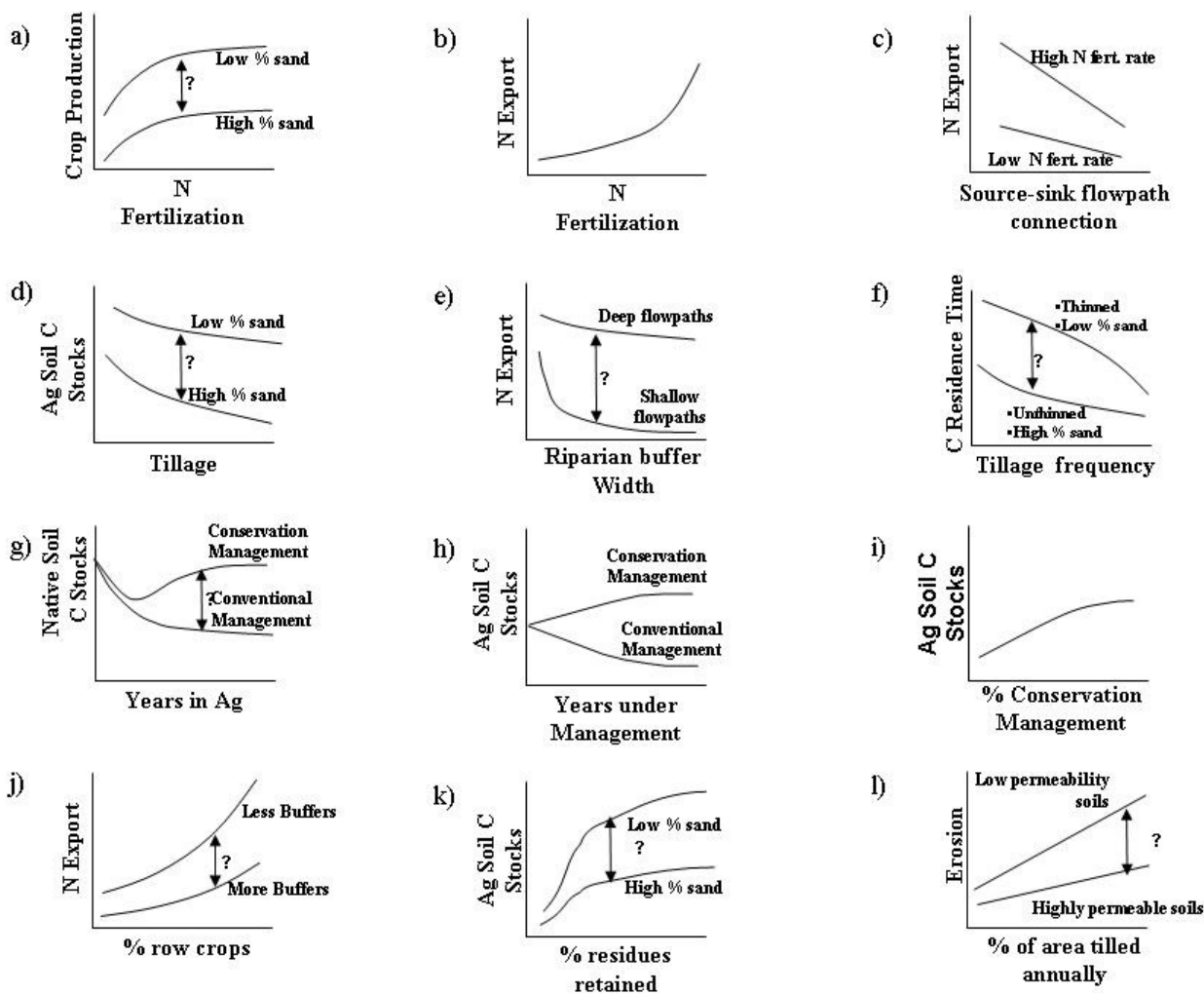
Gap Analysis and Prioritization by LU Categories in an ERF Format: **CONIFEROUS FORESTS**



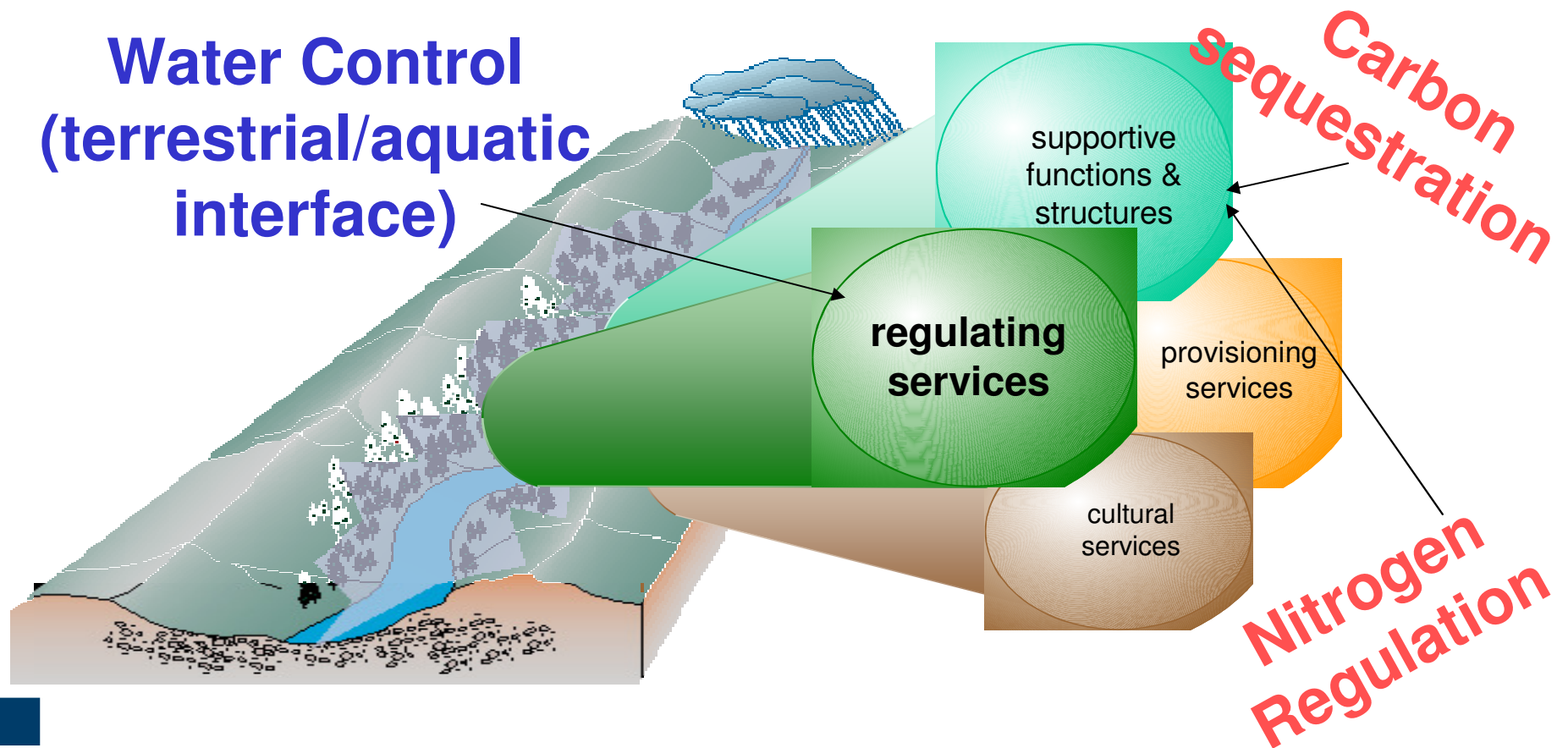
Gap Analysis and Prioritization by LU Categories in an ERF Format: **RIPARIAN WETLANDS**



Gap Analysis and Prioritization by LU Categories in an ERF Format: **AGRICULTURE**



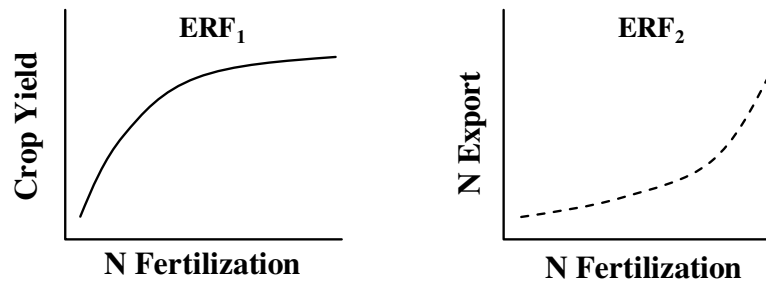
Bundled Stacks of Ecosystem Services



Definition of Terms

- **Forcing Variables**
 - Factors, both natural and anthropogenic, affecting quantifiable changes in the status (e.g. sinks, rates) of ecosystem processes
- **ERF: Ecosystem Response Function**
 - The relationships between ecosystem services and the natural and anthropogenic forcing variables affecting them
- **ETF: Ecosystem Trade-off Function**
 - The relationships between two (or more) ecosystem services and the same forcing variable (...and, eventually, multiple forcing variables)

Ecosystem Service vs. Forcing Variable = ERF

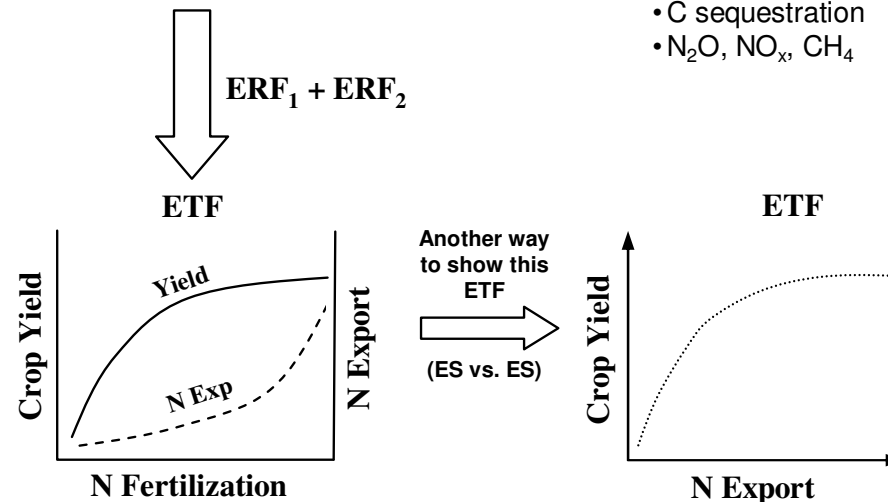


ERF X-axis: Forcing Variables

- N Fertilization (rate, timing, form)
- Harvest (interval, intensity, residues)
- Climate (Temp, Precip, Light, CO₂)
- Cover type (% landscape coverage)
- Riparian buffers (width, age, species)

ERF Y-axis: Ecosystem Services

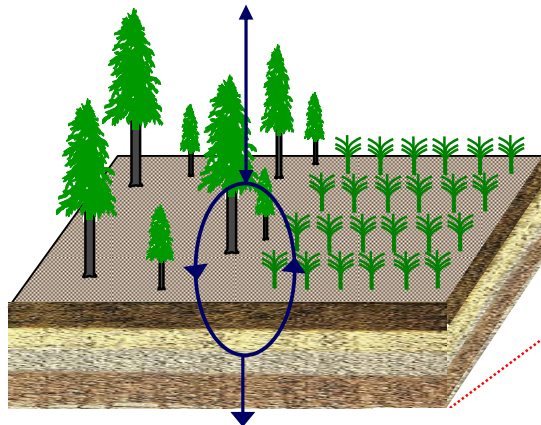
- Food/fiber yield
- Water quality
- Water quantity
- C sequestration
- N₂O, NO_x, CH₄



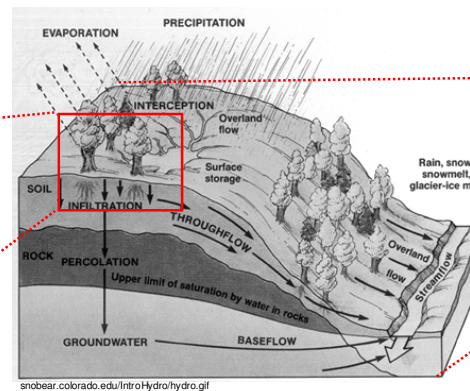
Socioeconomics

Valuation & Trading of
Ecosystem Services

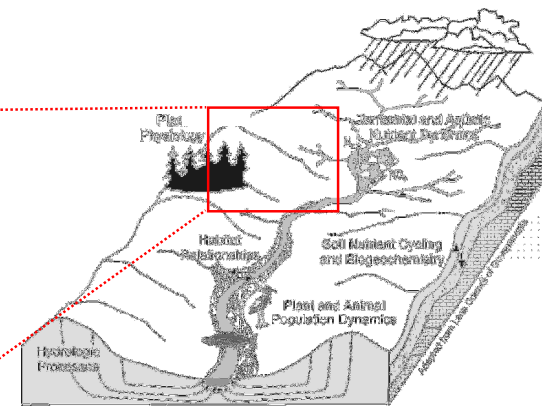
Experimental Research: Define ERFs & ETFs, Plots to Region



Plots, Stands

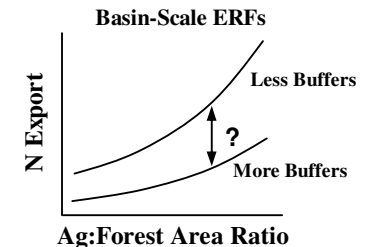
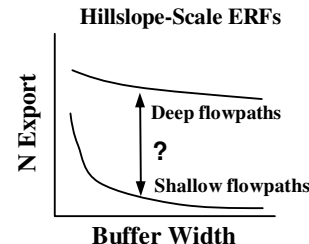
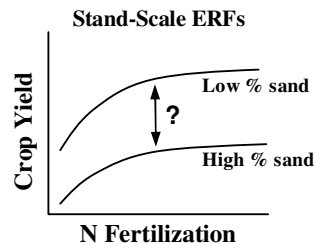


Hillslopes, Catchments



Basin, Region

Using nitrogen addition & export as an example...



Modeling Research:
Synthesize & Scale Up ERFs & ETFs – Plots to Region, Days to Centuries



- Ecosystem Service Prioritization & Trade-offs
- Alternative Future Analyses
- Regional Assessments



Willamette Ecosystem Services Project

Annual Performance Goals

Year 1 APG (FY 2008) Apply the Environmental Decision Toolkit to existing Willamette alternative futures data sets to determine its feasibility as a preliminary decision support tool for WESP.

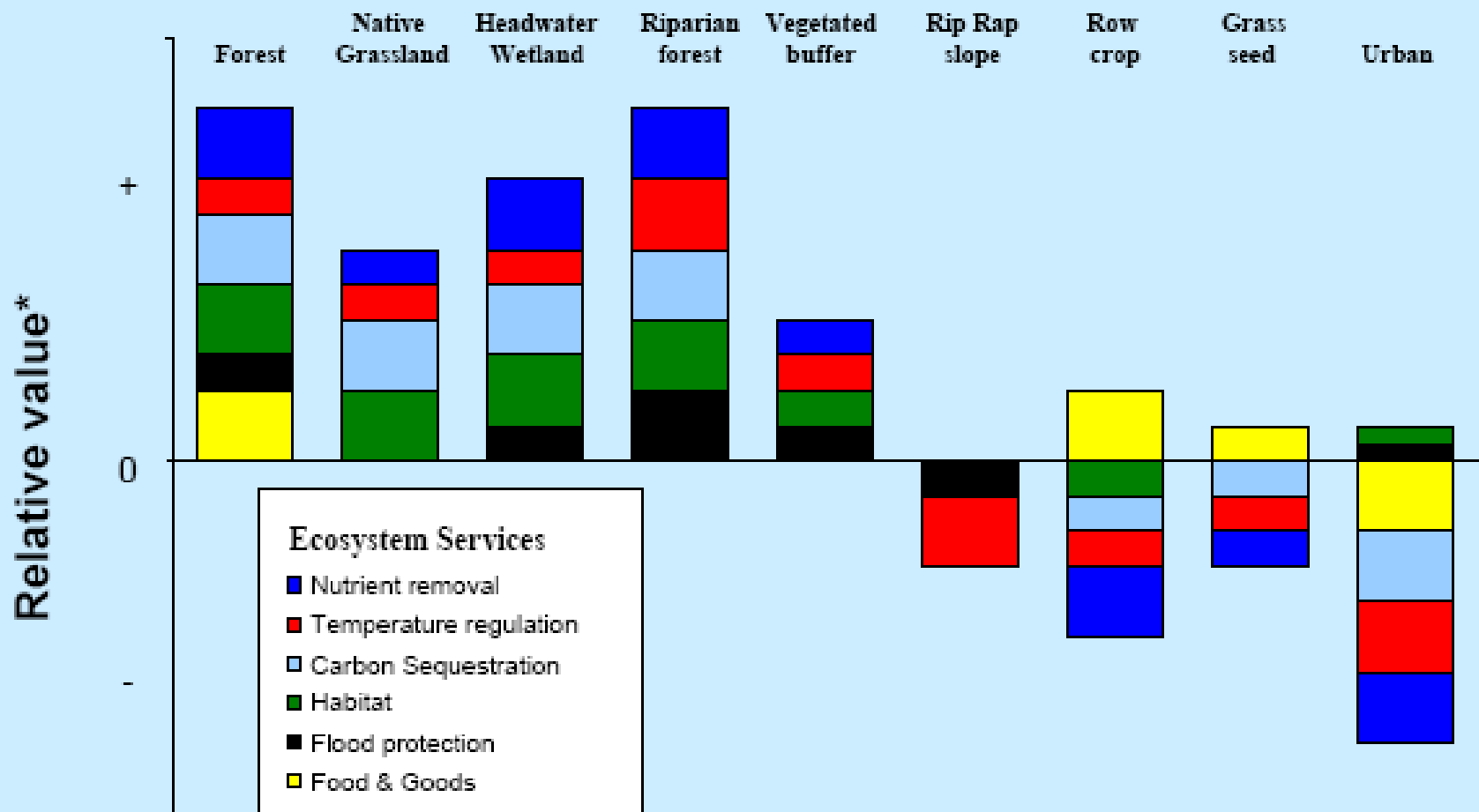
Year 2 APG (FY 2009) Map and inventory of status and trends for key ecosystem components and processes in the Willamette River Basin.

Year 3 APG (FY 2010) Address critical knowledge gaps between ecological processes and ecosystem services, so that measured processes can be translated into quantifiable ecosystem services.

Year 4 APG (2011) At an appropriate scale, determine the location and value of bundled ecosystem services in the Willamette Valley incorporating W- ESP research outputs that link Ecosystem service indicators and functions.

Year 5 APG (FY 2012) **Provide tool(s) that are used by Region X decision makers during FY 2013 to evaluate bundles of ecosystem services and options for their management and protection in the Willamette ecosystem services**

Hypothetical ecosystem service values: *Bundled by land use in the Willamette ESD*



*Relative value could be a rate, say kg/ha/yr, or represent economic or social value.

Status Assessment

■ Strengths

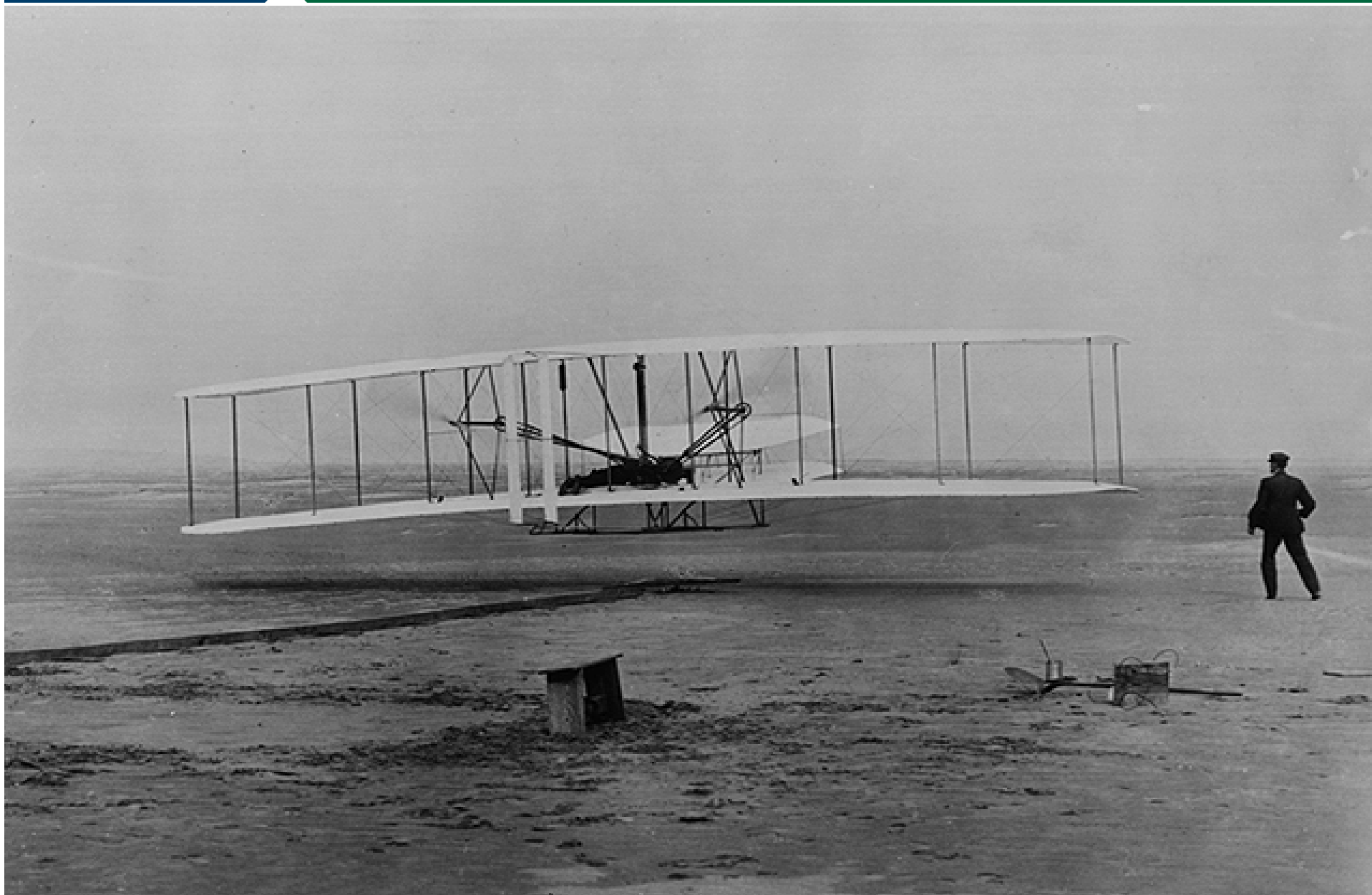
- - ~ 7 Ecology (aqua., terr., soil, plant)/3 Modeling FTE
- Strong research experience and buy-in to WESP
- Strong Division Support
- Excellent and engaged research community and pledges of collaboration
- Engaged 1^o Client – Region X

■ Weaknesses

- Thin in some critical skill areas: valuation, spatial eco-economics
- Need creative, young, experienced (??), modelers
- Projected budget is restrictive



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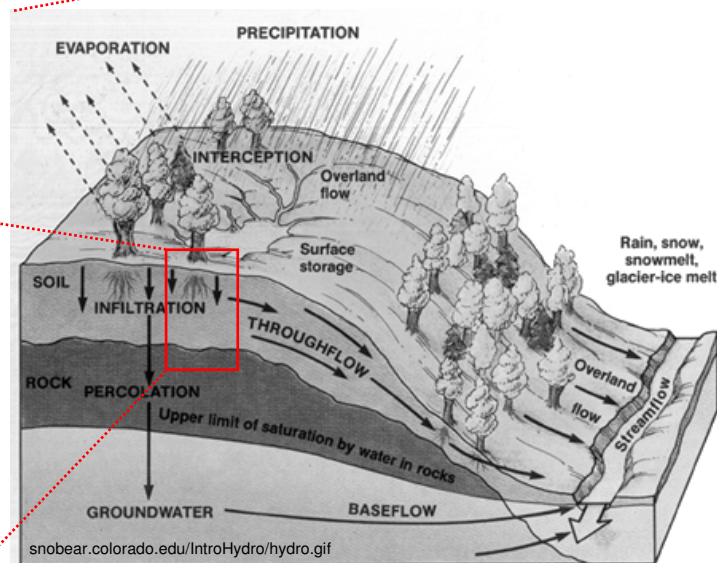
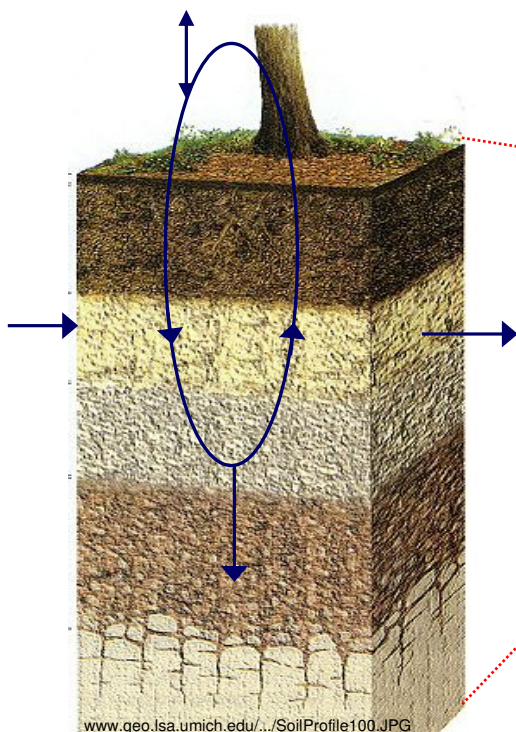


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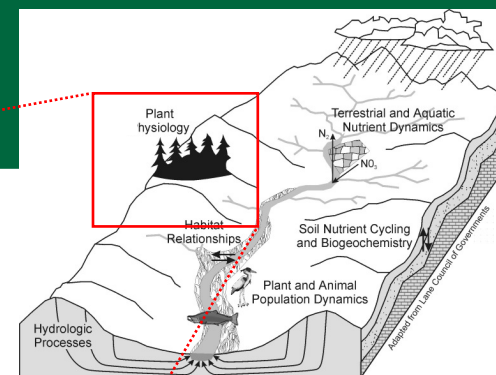
Let's Get to Work...



Approach...



Catchment-scale processes



Ecosystem-scale processes & services

Plot-scale processes **Mapping, Modeling, Synthesis, Scaling, Valuing**



Ecosystem Service Prioritization & Trade-offs
Regional Assessments
TMDL Analyses

Future Projections of Ecosystem Service Bundles and Value*